

Tungsten carbide for extruder wear parts

BY CLAYTON GILL

Aquafeed and petfood manufacturers now have another option for maintenance of high-wear extruder parts. Rather than replacing extruder barrels, barrel liners, screws, and dies, extruder operators can send them to metallurgical design-engineering firms that specialise in custom tools for extreme wear conditions. Or even order ‘extreme wear resistant’ as new spares.

One of the leading suppliers in this field is USA-based Conforma Clad, which specialised in rock drilling tools for oil and gas industries in the late 1960s. Today, the company’s proprietary wear-resistant process involves ‘cladding’ high-wear components with tungsten carbide.

Conforma Clad extrusion market manager Lorrie Muzzone told FEED INTERNATIONAL that the company got its start with feed extruders by applying the tungsten carbide cladding to original equipment screws and barrel liners supplied by petfood manufacturers. But, given its own in-house engineering and fabrication capability, the company soon started manufacturing wear parts ‘from scratch’ for most types of petfood and aquafeed extruders. What made retrofitting with tungsten carbide-clad parts attractive to feed makers, she said, was their much longer wear life: “Our pricing can be about twice that of the OEM (original equipment manufacturer), but with tungsten carbide cladding we expect anywhere from four to eight times the life of the OEM parts.”

Higher initial cost

The higher cost of tungsten carbide-clad parts stems from the manufacturing process. Basically, the company first manufactures the ‘substrate’—for example, a cast and machined extruder screw element with metallurgical properties to optimise cladding and subsequent operation of the extruder under specific conditions. Then technicians apply a flexible, organic cloth imbedded with evenly-distributed, size-controlled particles of tungsten carbide. The cloth can conform to complex geometries, such as the surfaces of screw flights. The technicians overlay the fitted tungsten carbide cloth with a similar cloth containing nickel, chromium, boron, and other braze elements. Then they heat the screw element in a vacuum furnace, which burns off the organics and ‘infiltrates’ the molten braze alloy throughout the tungsten carbide layer.

Performance comparison of wear protection methods

Method	Tungsten carbide cladding ¹	Thermal spray	Weld overlay	Wear tiles	Plasma spray
Bond strength	Very high	Very low	High	Low	Low
Use with complex geometries	Yes	No	Difficult	Difficult	No
Abrasion resistance	Very high	Moderate	High	Very high	Moderate
Erosion resistance	Very high	Low to moderate	Low	Low	Low
Corrosion resistance	High	Low	Low ²	Low	Low
Impact resistance	Moderate	Low	Moderate	Very low	Low
Oxide level	Low	High	Low	Low	Low
Temperature resistance	High	Moderate	Low	Very low ³	Moderate
Multiple modes of wear	Yes	No	Yes	No	No

¹Proprietary technology of Conforma Clad. ²Due to cracks. ³Due to adhesion.

Source: Adapted from ‘Technical bulletin: Standard tungsten carbide cladding formulas’, Conforma Clad, 2003.

“The resultant cladding,” the company says, “has no interconnected porosity, is uniform in depth and loading, and is metallurgically bonded to the substrate with a bond strength in excess of 70,000 psi (4,922 kg/m²).”

The performance of the tungsten carbide surface, the company states, extends beyond much greater resistance to abrasion from ingredient particles (figure ‘Dry sand abrasion’). There also is improved resistance to corrosion from chemical reactions (figure ‘Corrosion’) and erosion caused by liquid cavitation. According to Conforma Clad, tungsten carbide provides overall wear performance that is also superior to other steel wear protection methods (table ‘Performance’).

Wide range of maintenance approaches

Many factors play into just how the aquafeed or petfood manufacturer approaches extruder maintenance—especially replacement of relatively high cost wear parts. There are factors of scale: A single extruder in a single plant or several in multiple plants? There are factors of product type and quality: Tilapia feed from a large single screw extruder, or salmon starter feed on a twin screw? There are factors of plant personnel maintenance skill and experience: Can workers diagnose existing wear problems or anticipating potential problems? Also, there may be technical service and other contractual or less formal relationships with the extruder supplier.

In any case, Ms Muzzone says, the feed manufacturer probably has the benefit of knowledge of working with the OEM. If a particular extruder was purchased new, both should know the history of the machine based on service and maintenance records. Therefore, she says, the feed manufacturer should have the ability to make a “competitive value analysis” on OEM parts versus others.

Ms Muzzone acknowledges that the OEM is totally familiar with the design of the screw, for example, and has installed and, at least initially, configured the extruder for a particular range of tasks. She points out that the feed manufacturer and the extruder supplier may still enjoy a close working relationship. Nonetheless, she notes, tungsten carbide-clad components currently are installed in extruders operated by aquafeed manufacturers worldwide.

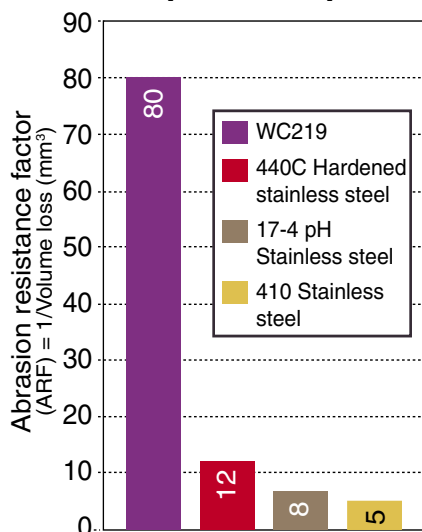
The rebuild option

The quality of the rebuild or rebuilt component—mostly barrels and screws—greatly depends upon the specialised skill of the rebuilders and which technology is used.

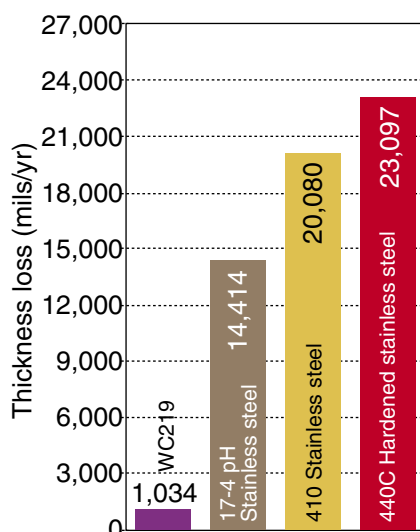
“You can put anything on the ‘OD’ (outside diameter),” Ms Muzzone says, “from a mild steel to a version of carbide hardfacing. So the life expectancy on the components could vary along with the cost. Typically, rebuilding is cheaper because the rebuilders are just taking the existing part and ‘welding it up’, then grinding it down ‘to spec’.

“But there are some serious issues with the re-

Dry Sand Abrasion Test (ASTM G65)



Corrosion Test (ASTM G31)



Note: ASTM G65: In all figures, WC indicates proprietary tungsten carbide cladding by Conforma Clad. Source: All figures adapted from 'Technical bulletin: Standard tungsten carbide cladding formulas', Conforma Clad, 2003. ASTM G31. Test with 10% hydrochloric acid at 212°F (100°C).

building process. The profile of the screw changes under wear during normal operation. In the process of rebuilding it, the grinding and polishing further change the profile. Even the metallurgical structure of the steel substrate can alter because welding by hand results in variable heat application."

"In operation," she adds, "the screw flights typically wear on the 'pusher' side, OD edge. So, as the rebuilders brings the OD back to spec, he might

add some welded reinforcement, but usually no hardfacing or other protection for the pusher side of the flight. With each rebuilding, then, the working face of the flights gets thinner and thinner."

In any case, Ms Muzzone emphasises, the rebuild is not brought back to original specifications, nor is the hardfacing comparable to a new tungsten carbide-clad component. In 'cladding', the tungsten carbide is applied as a coating, then goes

through a furnace cycle with brazed infiltration. "This forms a cladding with uniform thickness and a strong metallurgical bond."

Piecemeal or matched component replacement

Typically, Ms Muzzone says, original equipment screws wear out before the matching barrel liners. In such cases, a tungsten carbide screw could replace the OEM screw. She points out that no matter whether the replacement screw or the OEM screw came into contact with the liner, there would be accelerated wear. Still, Ms Muzzone adds, it is preferable to replace screws and liners simultaneously, while it is less important to install new tungsten carbide shearlocks, dies or wearplates at the same time.

FI asked, what about the OEM's warranty on the extruder if the feed manufacturer uses non-OEM parts, especially tungsten carbide-clad parts, which are going to be tougher than almost anything else in the machine?

Ms Muzzone points out that there has been an 'after market' for extruder parts for many years. "I am not aware of any warranty issue where any of the OEMs void the warranty of an extruder if, after initial installation, the customer switches to high-quality, non-OEM wear components." **fi**



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